Summer 2013

DroughtScape- Summer 2013

National Drought Mitigation Center

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DROUGHTSCAPE

The Newsletter of the National Drought Mitigation Center

DIRECTOR'S REPORT

Michael J. Hayes

It is good to be back in Lincoln, Nebraska, after my family and I spent two wonderful months in the Czech Republic. I was at Mendel University in Brno working with various colleagues on drought-related issues.

International activities -- exchanging ideas and sharing success stories on drought risk management strategies -- are an important component of the NDMC's mission. NDMC climatologist Dr. Tsegaye Tadesse just returned from his visit to Ethiopia, where he met with many government and university officials. Tadesse supervised an Ethiopian PhD student looking for better ways to identify drought and is part of an interdisciplinary group at the University of Nebraska-Lincoln working on water projects in selected pilot areas there. Scientists also come from around the world to visit with the NDMC staff. Since 2010, the NDMC has hosted 105 international visitors, with 23 of them staying for a week or more. Currently, the NDMC is helping both the School of Natural Resources (SNR) and the Center for Advanced Land Management Information Technologies (CALMIT) host two visiting scientists from Spain: Cristina Domingo (see story on page 15) and David Haro Monteagudo. In upcoming months, we'll host scientists from the Czech Republic, China, and South Africa. The mutual benefits and outcomes of interactions like these are often very slow to materialize and patience is essential, but the

continued on page 2

Nebraska groundwater dips after drought in 2012 -- what will it mean?

A recent report records the pulse of groundwater level changes in Nebraska following 2012's historic drought. How are these levels recorded and what will they mean for agricultural production, water levels and drought recovery this year? Read Jesse Starita's description starting on page 10 of what he learned on visits with water managers in Nebraska's Sandhills and corn belt. The aerial photo at the top of the page shows center pivot irrigation near O'Neill, Nebraska. Imagery ©2013 DigitalGlobe, Landsat, USDA Farm Service Agency, Map data ©2013 Google

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Help fine-tune Drought Management Database via July 25 webinar

Please help shape how we collect, store and distribute good ideas for coping with drought by joining a webinar on Thursday, July 25, noon-1 p.m. central time. The National Drought Mitigation Center will solicit comments on a Drought Management Database that is under development, and the National Integrated Drought Information System (NIDIS) Program Office will provide an update.

The NIDIS Engaging Preparedness Communities (EPC) webinar will be moderated by Deborah Bathke from the NDMC. Cody Knutson, NDMC, and Kelly Helm Smith, NDMC, will be the main speakers. The webinar will be interactive and will include a Q&A session.

If you have a moment, we invite you to review the new Drought Management Database in advance:

http://droughtdev.unl.edu/droughtmanagement/Home.aspx

A main question to consider while you are reviewing the new tool is:

How can we make the new drought management database and related products and tools as effective as possible in helping agencies and individuals prepare for drought?

Other related links:

- U.S. Drought Portal: http://www.drought.gov/drought/
- State-by-state planning info on the NDMC's website: http://drought.unl.edu/Planning/PlanningInfobyState.aspx

The webinar is free. Please register to receive log in information:

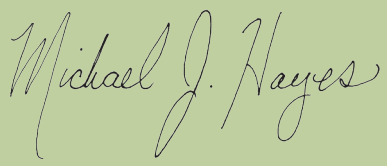
http://go.unl.edu/r8b

Questions? Please contact Nicole Wall, nwall2@unl.edu, 402-472-6776.

Director's report, continued

results can be invaluable. Don Wilhite's sustained effort working with the World Meteorological Organization that led to the launch of the Integrated Drought Management Programme earlier this year is an excellent example.

Drought was definitely not a factor in the Czech Republic during my visit this year, with significant rains during May and June leading to serious flooding in Prague and other locations. But all that rain provided the perfect opportunity to think strategically about drought. Colleagues reviewed the drought they had in 2012 to see how they could use the signals within the indicators and impacts to improve on a drought early warning system. Drought researchers in the United States are wrestling with similar issues.



CONTACT THE NATIONAL DROUGHT MITIGATION CENTER

P.O. Box 830988
Lincoln, NE 68583-0988
USA

819 Hardin Hall
3310 Holdrege St.
School of Natural Resources
University of Nebraska–Lincoln
East Campus

email: ndmc@unl.edu
phone: (402) 472-6707
fax: (402) 472-2946

Contact the editor of DroughtScape, Kelly Helm Smith: ksmith2@unl.edu

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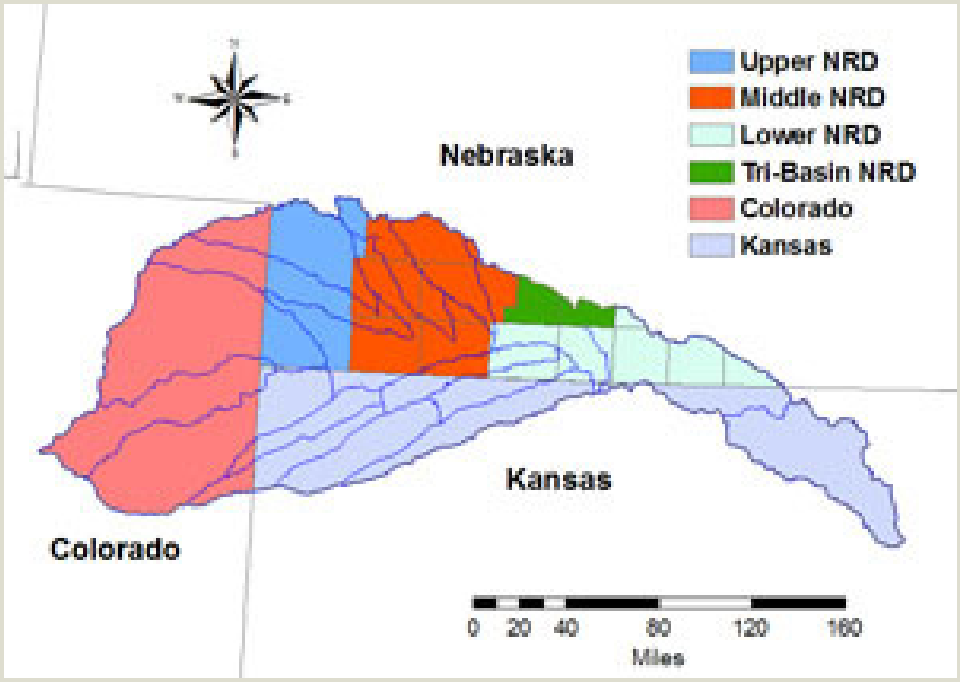
Workshops July 31 & August 1 to focus on drought and management tools for the Republican River Basin

Upcoming workshops in the Republican River Basin will provide an assessment of the ongoing drought and a look at newly developing tools for managing drought, climate and water in the watershed that includes parts of Colorado, Kansas and Nebraska.

The Republican River Restoration Partners and the National Drought Mitigation Center at the University of Nebraska-Lincoln are partnering to host workshops on July 31 in Oberlin, Kansas, at the Gateway Center, 1 Morgan Drive, and August 1 in Alma, Nebraska, at the Johnson Center, 509 Main St. The workshops will start promptly at 9:25 a.m., with registration opening at 9:00 a.m. The workshops are free and open to the public, and lunch will be provided. The organizers would appreciate it if participants register in advance.

At the Alma meeting, Susan Stover, representing the Kansas Water Office, and Jesse Bradley, from the Nebraska Department of Natural Resources, will give an update on the WaterSMART project sponsored by the U.S. Bureau of Reclamation. They will cover the feasibility of raising the level of Lovewell Reservoir and ways to improve conjunctive water use management involving surface and groundwater. The project study is supported by Colorado, Kansas and Nebraska.

Nebraska State Senator Tom Carlson, who is involved with the state's Water Funding Task Force, will wrap up the workshop with an update on the task force activities.



The Republican River Basin includes parts of Colorado, Nebraska and Kansas.

Mark Svoboda, leader of the Monitoring Program Area at the NDMC, will give an update on drought conditions in the basin and demonstrate the new Drought Risk Atlas developed by the NDMC.

Jae Ryu, a hydrologist at University of Idaho who was formerly with the NDMC in Nebraska, will present his research on drought monitoring indicators and initial work to develop future climate scenarios for the Republican River Basin.

Stephen Gasteyer, a sociologist at Michigan State University and Drought Center collaborator, will describe interdisciplinary approaches to modeling the High Plains Aquifer system, focusing specifically on the Republican River. In particular, he will focus on how interdisciplinary modeling can enhance efforts to adapt to changing physical and socio-economic conditions.

Participants will also have a chance to tell Gasteyer and Ryu how their research could be used in decision-making for the basin.

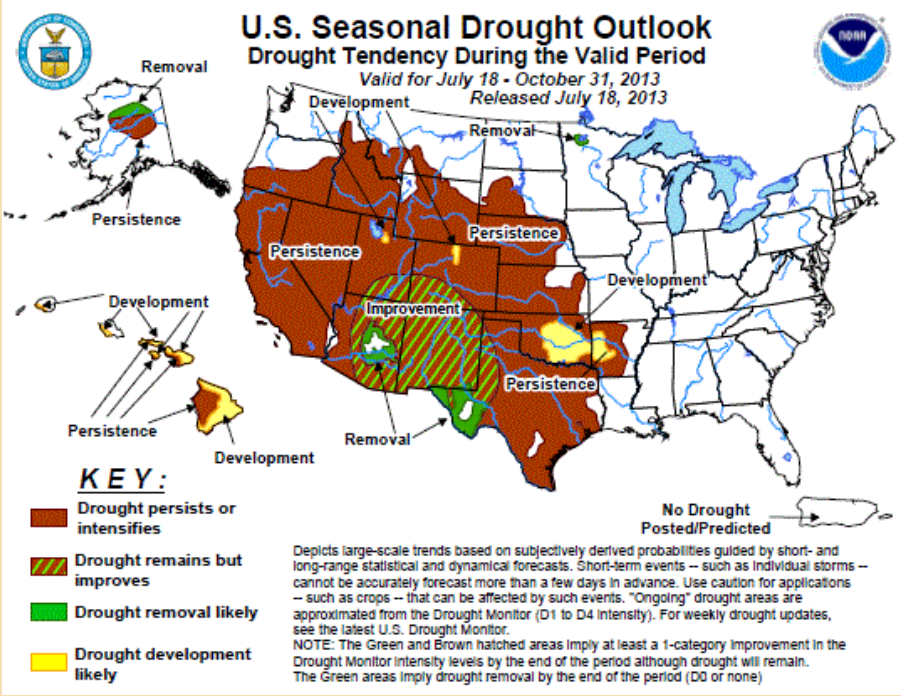
If you are interested in attending one of the workshops, please register by contacting Ted Tietjen, chairman of the Republican River Restoration Partners, 308-352-4336. For more information, please contact Nicole Wall at the NDMC, nwall2@unl.edu.

Summer outlook -- continued dry in the west -- and April to June

By Brian Fuchs, Climatologist, National Drought Mitigation Center

Drought classifications are based on the U.S. Drought Monitor. Details on the extent and severity of drought are online at http://droughtmonitor.unl.edu/archive.html. The outlook integrates existing conditions with forecasts from the National Oceanic and Atmospheric Administration's Climate Prediction Center: http://www.cpc.ncep.noaa.gov/

April: A wet and cool pattern reduced the extent and intensity of drought in April. The proportion of the contiguous United States in drought receded from 51.92 percent at the beginning of the month to 46.90 percent at the end. The proportion in extreme and exceptional drought improved from 17.13 percent to 13.96 percent. The Midwest continued to see conditions improve as portions of eastern Iowa, northern Illinois, Indiana, and Michigan received 5-6 inches above normal precipitation. As conditions in the central Plains and Midwest improved, the West remained dry and very little precipitation was recorded, even in the upper elevations. In stark contrast to 2012, temperatures for the month were well below normal for most of the United States except for the West Coast and the Southwest, Florida and portions of the Mid-Atlantic. Areas of the Dakotas were 12-15 degrees Fahrenheit below normal for the month.

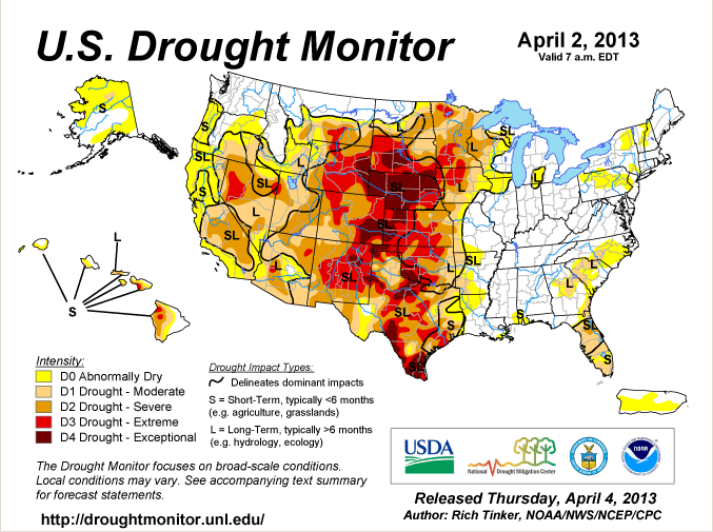


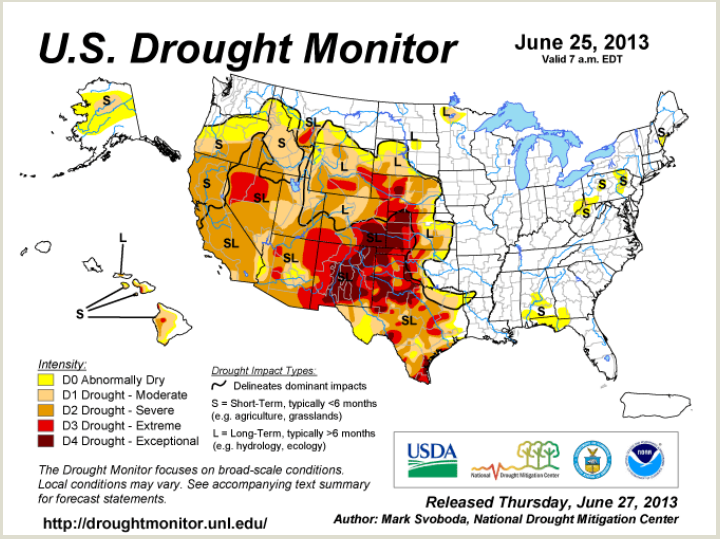
Outlook: Conditions during the summer continue to favor drought over the western United States, with little to no drought east of the Missouri River. A strong monsoon season is expected over the Southwest, which should bring some improvements to Arizona, New Mexico, southern Utah and Nevada as well as west Texas. Portions of Arkansas and Oklahoma that are currently drought free should expect drought to develop over the coming months. Hawaii will continue to battle drought conditions with most of the Islands having drought conditions persisting and experiencing further development.

May: The weather pattern observed in April continued into May. Most of the Midwest and central Plains remained in a wet pattern, while the West remained warm and dry. As was the case in April, portions of Iowa, Illinois, Wisconsin and Missouri received precipitation of as much as 3-6 inches above normal. Areas in the upper Missouri River Valley and the lower Mississippi Valley also had wet months, with precipitation 3-6 inches above normal. Drought improved overall during the month, as 44.38 percent of the contiguous 48 states was in drought at the end, compared to 46.90 percent at the start of May. The areas of extreme and exceptional drought also improved more this month, going from 13.96 percent at the beginning to 11.75 percent at the end. As drought improved in the Midwest and central Plains, it expanded and intensified over the western United States. New Mexico ended May with 44.87 percent of the state experiencing exceptional drought, compared to 24.89 percent at the beginning of the month.

June: The wet pattern continued over the eastern half of the United States while the western half remained dry. Over the last several months, the gradient of drought from east to west became more evident, with a stark contrast in conditions in just a few hundred miles, in some instances. The delineation line appeared along the Missouri River. Areas to the east of the Missouri River generally were drought-free, with only a few

summary

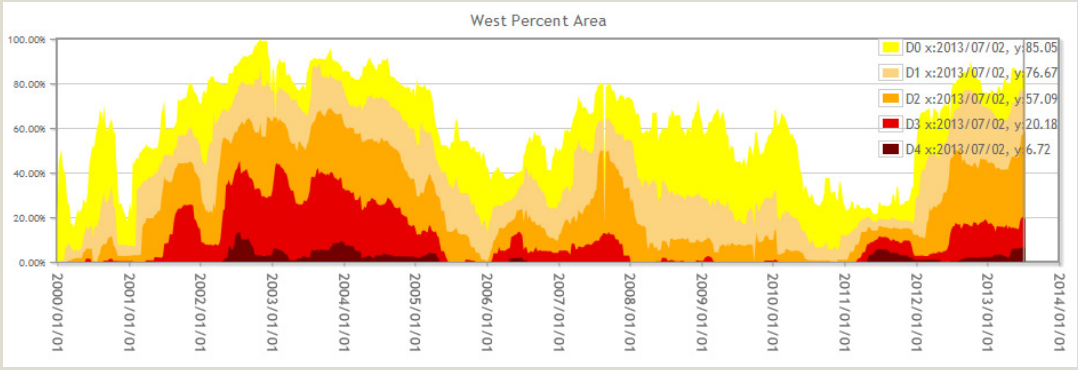


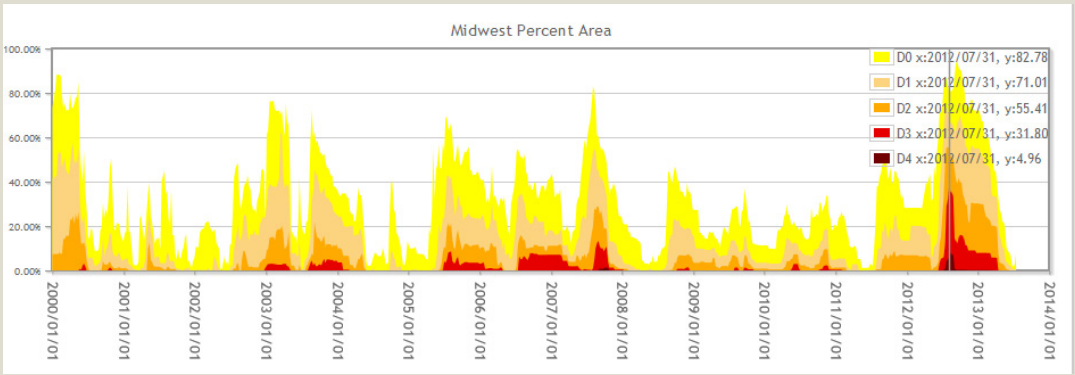


Drought's U.S. footprint finally receded below 50 percent of the area of the lower 48 states on the April 16 U.S. Drought Monitor map. It had been above 50 percent since June 26, 2012. The percentage of the country in moderate drought or worse was 51.92 percent as of April 2. It got down to 43.84 percent on June 25 and has since crept up to 46.13 percent as of July 16.

areas of dryness. Areas to the west of the Missouri River were dry, with drought intensifying in many locations. June ended with 43.84 percent of the contiguous 48 states in drought, compared to 44.34 percent at the beginning of the month. For the western United States, June ended with 76.67 percent of the region in drought, compared to 71.11 percent at the beginning of the month and 62.69 percent a year ago. Temperatures in the western United States were also starting to affect the region, as most areas were 4-6 degrees Fahrenheit above normal for the month.

The charts at right show drought on the rise in the West, top, and declining in the Midwest, bottom, since the start of this year.

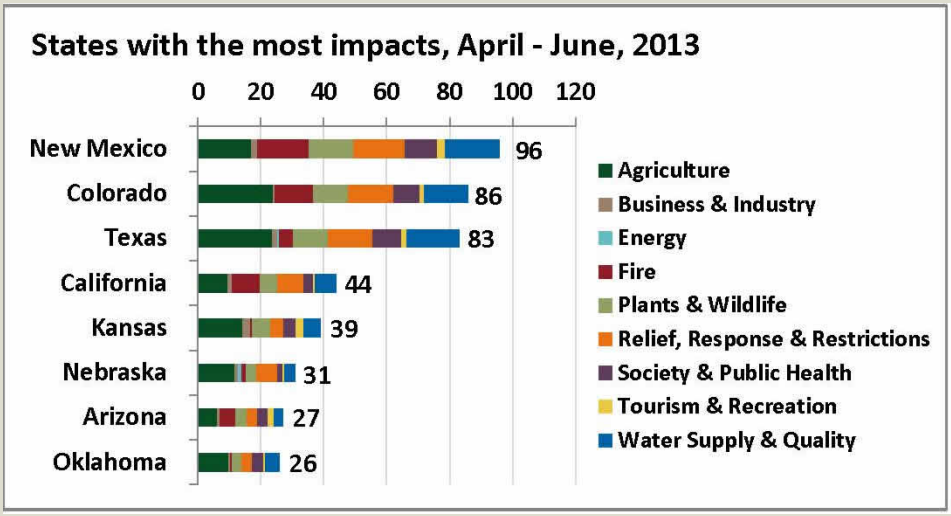




Spring drought impacts: wildfire, water supply, winter wheat

by Denise Gutzmer, NDMC Drought Impact Specialist

The Drought Impact Reporter logged 461 impacts for the nation in the second quarter of 2013. Impacts come from a variety of report types, including media reports from an automatic search that are entered by an NDMC moderator, user reports entered by observers across the country, and citizen science observers participating in the Community Collaborative Rain, Hail and Snow Network. Identifying and counting impacts is still an inexact science, but it serves as a rough indicator of where people are most concerned about drought's many direct and indirect effects.



New Mexico

Wildfires, meager water supplies and ongoing agricultural challenges have been hitting New Mexico hard as the state endures its third year of drought. The NDMC recorded 96 impacts for the state in the second quarter of 2013. Water supplies are down in much of New Mexico, with the Rio Grande facing its worst irrigation water shortage in nearly a century. Magdalena ran out of water, and the Navajo Nation and the town of Cloudcroft declared water emergencies as their supplies ran very low. The Middle Rio Grande Conservancy District, the Elephant Butte Irrigation District and the Carlsbad Irrigation District were forced to cut deliveries to just a fraction of the water they normally deliver because the thin snowpack this winter did not contribute much to reservoirs. Farmers turned instead to wells, risking more saline water, which can harm crops.

"Navajo Nation declares drought emergency," Associated Press, in the *Amarillo (Texas) Globe-News*, July 2, 2013.

"Cloudcroft Declares Water Emergency," KRWG News (New Mexico and Texas public radio), July 3.

Wildfires in New Mexico also devoured more than 192 square miles from late May through late June, with the Silver Fire in the Gila National Forest charring at least 127 square miles. Wildfires on grazing land have forced ranchers to move cattle out of state.

"Silver Fire jumps to 127 square miles," by Susan Montoya Bryan, Associated Press, *Las Cruces Sun-News*, June 25, 2013.

Colorado

Ongoing drought led to a total of 86 impacts for Colorado, where wildfires scorched roughly 180 square miles in the first half of 2013, with flames from the Black Forest Fire north of Colorado Springs destroying more than 500 homes and taking two lives. The fire caused $85.4 million in damage, according to El Paso County Assessor Mark Lowderman in an Associated Press report. A Denver ABC TV affiliate said the cost of fighting the wildfire was more than $8.5 million, citing Incident Commander Rich Harvey. Hay supplies and production were down in Colorado, dealing a harsh blow to horse owners who cannot afford hay. Water supplies for irrigation were low, particularly in the southern part of the state.

"Drenched East, parched West: Colorado wildfires 2013," by Amanda Morgenthal, *Washington (D.C.) Post,* July 2, 2013.

"Coffee shop regulars escape wildfire," by Josh Arndt, *The (Nashville) Tennessean*, July 16.

Texas

Texas also felt the burn of ongoing drought, with 83 impacts, as water supplies continued to dwindle and low soil moisture hurt crop production. Soil moisture levels have not recovered from years of drought, leaving pastures and crops struggling. Cattle sales continued. Barnhart in western Texas ran out of water, and numerous lakes were near or at historical lows.

California

Drought in California dried up pastures, led to livestock sales, reduced water supplies and shortened irrigation allotments. For example, drought cost Tehama County $6.9 million in agricultural losses so far in 2013. Much of the damage is to rangeland, for a loss of about $6.1 million, barley production, at a value of roughly $275,000, and hay, valued at $523,300. Dry conditions and the uptick in fire activity statewide have fire officials warning that this fire season could be the worst in a century. Through mid-June, roughly 50 percent more fires had scorched nearly four times as

Taken on May 3, 2013, this photo shows the effects of drought on Medina Lake, near San Antonio, Texas. Medina Lake is down to 5 percent of capacity. Photo by Mark Florence.

many acres than at the same point in 2012, according to Cal Fire. California had 44 impacts recorded in the second quarter.

"Tehama County drought finding sought," by Rich Greene. *Red Bluff (California) Daily News*, July 3, 2013.

"WILDFIRES: Conditions ripe for volatile season, officials predict," by John Asbury, *Press-Enterprise*, Riverside, California, June 19, 2013.

Kansas

Kansas' winter wheat crop and pastures suffered from ongoing drought and late spring freezes. The state had 39 impacts reported from April through June. The Risk Management Agency office in Topeka had received indemnity claims for $33.5 million for 2013 as of June 8. Of the 9.4 million acres affected, more than $31 million of the claims were for the damaged wheat crop. Poor pastures and unusually low hay stocks kept livestock producers culling cattle. Lake levels were low statewide, but particularly in western Kansas. Many streams were at historically low levels, and many stock ponds were dry, forcing farmers to haul water or relocate cattle.

"In Kansas, drought, freeze paralyze wheat crop," Associated Press, *Kansas City (Missouri) Star,* June 8, 2013.

"Drought puts hay supply at new low," by Amy Bickel, *The Hutchinson (Kansas) News,* May 26, 2013.

"Kansas lake levels low for Memorial Day," Associated Press, *Salina (Kansas) Journal,* May 26, 2013.

Nebraska

Hay supplies were scarce and pastures were in poor shape in Nebraska, accounting for some of the 31 impacts for the state. The National Agricultural Statistics Service expects Nebraska's wheat harvest to be 42.9 million bushels or 20 percent smaller than the 2012 wheat crop as drought continues to hamper plant growth. This is Nebraska's smallest crop of wheat since 1944.

"Report anticipates smallest Nebraska wheat crop since 1944," Associated Press, *Omaha (Nebraska) World-Herald,* May 13, 2013.

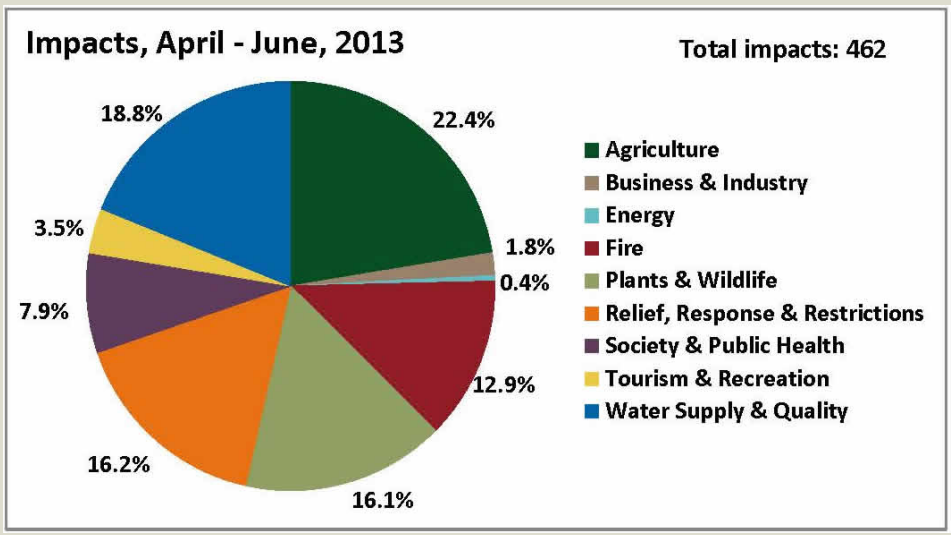
Arizona

Wildfires flared across Arizona, including the Yarnell Hill Fire, which took the lives of 19 firefighters on June 30. Fire restrictions prohibited open burning in some national forests. Native trees and plants were stressed and dying in parts of Arizona and surface water was scarce, leading to rescue efforts to supply wildlife with water. Wildfires and fire restrictions accounted for many of the 27 impacts for the state.

"Water is a wonderful thing and the Arizona Elk Society is making it happen," by Scott Kelly, CEO - Black Dog Promotions, AZCentral.com, June 25, 2013.

Oklahoma

Southwestern Oklahoma saw water restrictions as continued drought dried up lakes and reservoirs. Cotton planting was delayed for lack of rain. The low water level of Lake Altus-Lugert in Quartz Mountain State Park drew fewer visitors, causing a drop in revenue for the park. The water level in the lake dropped by 20 feet, leading to fish kills. Most of the state's 26 impacts described



continued on page 8

Drought impacts, continued

agricultural issues, such as the damaged winter wheat crop and cattle sales .

"Lack of Rainfall Concerns Oklahoma Cotton Farmers as Planting Gets Underway," by Randy Boman, Oklahoma State University Extension, in the Oklahoma Farm Report, May 31, 2013.

"Business still good at Lake Lugert despite water level," *Lawton (Oklahoma) Constitution,* June 30, 2013.

Wildfires

In May, the National Interagency Fire Center in Boise released a forecast for the fire season anticipating above-normal fire activity in Arizona, New Mexico, California and Oregon, and parts of Montana, Idaho, Colorado, Utah and Washington. Fire activity has been significant in these states, with more than 1 million acres blackened in Alaska in 451 wildfires. California has seen the most wildfires, with 4,657 fires burning 86,325 acres this year.

"Fierce fire season predicted for West," *USA Today*, May 14, 2013.

Wildland Fires		
State	Acres	Fires
Alaska	1,043,908	451
New Mexico	200,205	771
Colorado	131,447	551
Nevada	117,247	266
Arizona	91,509	1,058
California	86,325	4,657
Oregon	46,846	487
Idaho	44,203	273
Minnesota	20,954	959
Alabama	20,936	888
Oklahoma	20,380	390

These are the year-to-date statistics for wildfires in the U.S for states with more than 20,000 acres burned, through July 11. All of the states are affected by significant areas of drought, except for Minnesota and Alabama. From the National Interagency Fire Center.

Agriculture

Indemnities for 2012, when drought devastated corn in the Midwest, rose to $17.1 billion. Taxpayers will pay about 75 percent of the cost, said the Environmental World Group. The previous record for indemnities in a year was set in 2011 at $10.843 billion. Indemnity payments in 2010 were $4.251 billion. Farmers bought crop insurance for roughly 282 million acres of crops in 2012, 6.1 percent more than in 2011. The crops suffering the most damage from drought were corn, wheat, cotton, soybeans and grain sorghum.

Drought and late spring freezes damaged the winter wheat crop, reducing yields in Colorado and the Dakotas south to Texas. Poor pasture condition and low water supplies drove cattle producers to cull cattle from Colorado to western South Dakota to Texas. Hay stocks nationwide on May 1 were 14.2 million tons, the smallest amount since 2007 and the least amount on hand on May 1 in data going back to 1973. The lowest hay stocks compared to the 10-year average were found in the Midwest from Ohio to South Dakota to Kansas and Missouri.

"Deeper Cuts Seen as Congress Returns to Farms, Food Stamps," by Alan Bjerga, Bloomberg, May 13, 2013.

"U.S. Crop-Insurance Claims Rise to Record After 2012 Drought," by Jeff Wilson, Bloomberg, Jan. 15, 2013.

"Indemnity checks flow to farmers after the 2012 drought," National Crop Insurance services, *Farm Industry News*, Nov. 20, 2012.

"Reports signal limited year for forages," by Randy Pirtle, E-E Columnist, May 16, 2013.

Western Water, Irrigation and Reservoir Storage

Parts of the West did not receive enough snow this winter to meet water needs during the summer, forcing irrigation districts in nearly every state to end water deliveries early. Reservoirs were less than 50 percent of capacity in New Mexico, where several irrigation districts were able to provide only a few acre-inches of water. These water deliveries are usually described in terms of acre-feet. Nevada, Colorado and Arizona also had average reservoir storage amounts of less than 50 percent. Fortunately some late winter storms blew through and deepened the snowpack in parts of Utah, Wyoming and Colorado in April, averting what could have been a worse water supply scenario.

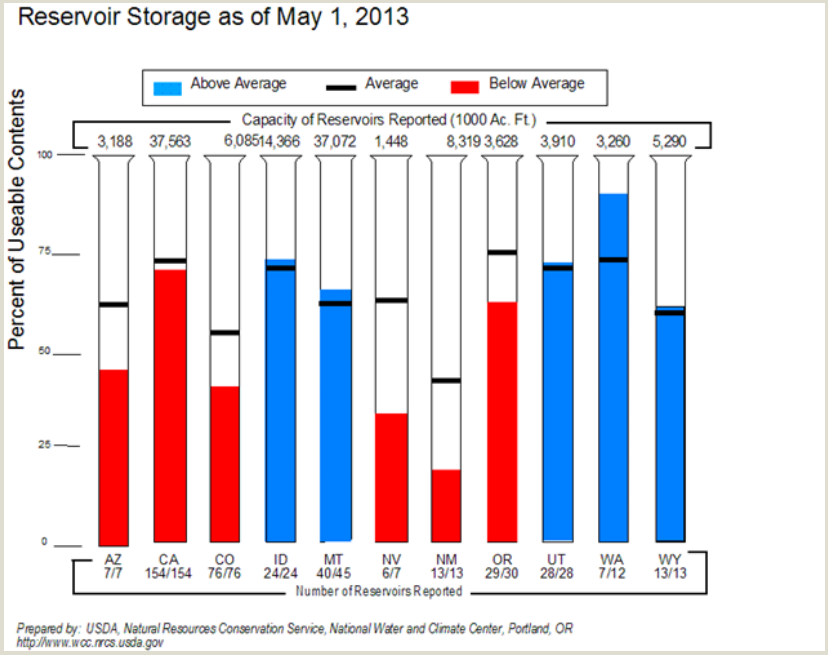
Business, Industry, Economy

Agriculture-related businesses, such as ethanol or grain handlers, can profit or lose revenue in drought years when grain prices are high and supplies are low as in 2012. High grain prices lowered profits for ethanol producers and a shortage of grain brought some ethanol producers to a standstill until the next harvest. In the meantime, corn prices have fallen, allowing at least one ethanol plant to reopen.

Net income for DuPont, based in Wilmington, Delaware, rose more than 50 percent to $3.35 billion, or $3.58 per share, during the first quarter of 2013, compared to the previous year, as farmers rushed to purchase drought-tolerant seeds and crop-protection products to increase yields.

"DuPont profit doubles as drought boosts farm sales," Reuters, April 23, 2013.

Cargill Inc., based in Minneapolis, Minnesota, saw its fiscal third quarter earnings plummet by 42 percent to $445 million, compared to the previous year, as drought hampered meat-processing and grain-handling operations. Corn prices skyrocketed, due to drought in 2012, sending feed costs higher for



meat processors. Cargill closed one of its meat-processing plants in Plainview, Texas, in February. Earnings declined in four of the company's five business segments.

"Cargill Profit Falls 42% on Pressure From Drought," *Wall Street Journal*, April 9, 2013.

In early April, Bunge announced that it would shutter a soybean-processing plant in Emporia, Kansas, until the next harvest became available.

"Drought forces Emporia soybean plant to lay off workers," by Jason Johnston, *Emporia (Kansas) Gazette*, April 3, 2013.

Archer-Daniels-Midland Co., the largest corn processor, saw its net income fall by a third to $269 million, or 41 cents a share, down from $399 million, or 60 cents a share compared to spring 2012. The company's chairman and chief executive officer stated, "This was a challenging quarter, with agricultural services negatively impacted by the ongoing effects of last summer's U.S. drought."

"ADM to Proceed With $2.3 Billion GrainCorp Deal After Review," by Shruti Date Singh and David Stringer, *Washington (D.C.) Post*, May 1, 2013.

The small corn crop in 2012 left grain buyers eagerly awaiting the 2013 corn crop, but the cool, wet spring delayed planting, putting grain handlers in a bind. Just 28 percent of the corn crop had been planted as of May 13 which will mean a later harvest, drawing corn inventories down during the third quarter to very low levels. In the meantime, more acreage has been devoted to corn than ever before, leading to predictions of a record crop.

"Late corn crop likely to push up costs for Bunge, ADM and other grain buyers," by Shruti Date Singh, Bloomberg News, *St. Louis Post-Dispatch*, May 15, 2013.

Monsanto's fiscal third quarter earnings were down 3 percent due to poorer performance in the company's cotton and soybean segments and drought-related expenses, the company revealed on June 26, 2013. The 2012 drought in the Midwest led Monsanto to rely more on greenhouses in South America to grow corn seeds, resulting in a 7 percent price increase for goods sold in this year's quarter.

"Monsanto's quarterly profit sinks 3 percent," Associated Press, *Dubuque (Iowa) Telegraph-Herald*, June 27, 2013.

The economies of drought-affected states in 2012 also took a hit as smaller incomes led to poor economic growth. In 2012, Nebraska's economy grew 1.5 percent after adjustments for inflation, in comparison with 2.5 percent nationally, according to preliminary data from the U.S. Bureau of Economic Analysis. Iowa's economy grew 2.4 percent. The preliminary estimate of South Dakota's gross domestic product was 1.9 percent, in comparison with an increase of 8.8 percent in 2011, according to the U.S. Bureau of Economic Analysis.

"Nebraska, Iowa trailed nation's growth in 2012," by Henry J. Cordes, *Omaha World-Herald*, June 7, 2013.

"Drought blamed for sag in farm sector causing drag on state's GDP," by Megan Card, *Argus (South Dakota) Leader,* June 11, 2013.

For more detail on these and many more impacts:

Drought Impact Reporter
http://droughtreporter.unl.edu

Submit a report, even upload photos:
http://public.droughtreporter.unl.edu/submitreport/

Data help managers assess groundwater declines after drought

Story, photos and video by Jesse Starita, Education Outreach Associate, Robert B. Daugherty Water for Food Institute

It's early June in Nebraska and inside a small office in a beige brick building a man is running his fingers over graphs. The bare bones, black-and-white plots could easily pass for cardiographs or NASDAQ indices. Yet instead of heart rate or stock fluctuations, this data-fortified hydro-fortune teller is holding something else: the first physical for the health of Nebraska's water table following 2012's debilitating and record-setting drought.

If Aaron Young doesn't look like a psychic or a doctor, that's because he's neither. Nestled in his den in Hardin Hall wearing jeans and a Husker-red polo, wire rim glasses and a French cut, Young looks the part of Survey Division Coordinator with the University of Nebraska-Lincoln's School of Natural Resources. He's more comfortable making parabolas than predictions. This fall, he'll be the lead author of a comprehensive groundwater-level report assimilating data from 5,500 well readings across the state and giving voice to the drought's impact. But for now, this physical bears witness to 2012's severity.

Aaron Young, Survey Division Coordinator in the University of Nebraska-Lincoln's School of Natural Resources, beside one of the many groundwater recorder wells he measures.

"Most of these wells have seen record declines from the spring of 2012 to the spring of 2013," Young notes, referring to the five representative wells spread throughout the state, and seven decades' worth of annual groundwater reports by the University and the U.S. Geological Survey.

While yearly drawdowns during the irrigation season are not novel, their post-2012 quantities are. The drought has eased somewhat in western Nebraska but is still ongoing a year later. In Elgin, a small town near the Sandhills' eastern edge, groundwater levels fell by 5.5 feet. That's more than double the previous one-year maximum decline of 2.17 feet. And in Shickley, 130 miles south, a drop of nearly 3 feet set a new record. The extreme drought rewrote almanacs and kept Young busy.

"I had people calling me back in December, wanting to know about water levels in their area."

Falling groundwater levels are no surprise in Nebraska and Wyoming, the only two states in 2012 to experience both their hottest and driest years on record—like being bear-hugged by the Atacama Desert and Arabian Peninsula. Due to drought, groundwater levels would have dropped even without pumping water for irrigation. The drought's impacts varied with local conditions and land uses across the state.

> ***"Last year is impacting this year because the pastures were grazed short. In the fall we did not get regrowth on those pastures or the hay meadows...so their pastures are showing the impact of last year."***
>
> ***– Dennis Schueth, Upper Elkhorn NRD***

These days, drive into O'Neill, Nebraska, along U.S. 281—a scenic two-lane highway that runs 1,872 miles from Canada to Mexico—and the drought seems nearly vanquished. Here, in the state's northeast, Elkhorn River channels brim with stout toads and lush bluestem on which contented cattle graze. But is this freeze-frame too narrow? In these parts, few can answer that question like Dennis Schueth.

Like Young, Schueth wears jeans, glasses, a beard and a red embroidered polo. Unlike Young, chalky streaks color his hair and his shirt is emblazoned with the logo of the Upper Elkhorn Natural Resources District (NRD). That's where he's been for the last 27

# of 2012 in Nebraska

years—working up to general manager of one of the 23 NRDs that are charged with conserving and protecting Nebraska's natural resources. Each NRD is governed by a locally-elected board of directors. Schueth praises his board for its approach to dealing with the drought.

"Sometimes too much of a good thing can hurt. Especially when we're talking about the resources, soil resources and water itself. I think it's a great thing that our board of directors has kind of taken an approach of let's look at really what the data is showing," he says.

What the data show is a stark mix of dichotomies, trade-offs and market forces at work: Record groundwater level declines against record irrigated crop yields. Record low dryland yields against record high irrigated yields. Widespread crop failure and record farm indemnity payments. Agricultural irrigation against urban water consumption. And, in Schueth's backyard, corn's record profitability and a financially parched cattle industry grappling with high feed and pasture costs. "Last year is impacting this year because the pastures were grazed short," he notes. "In the fall we did not get regrowth on those pastures or the hay meadows…so their pastures are showing the impact of last year."

A mural along Highway 281 depicts the landscape's most prominent features.

Unlike row crops, there is little recourse for pastures if precipitation clocks out – few wells to tap or drought-tolerant varieties to test, and no crop insurance to backstop income. Antelope, Holt, Rock and Wheeler counties, which comprise the Upper Elkhorn NRD, are representative of the macro trends in the livestock industry. High corn prices have driven some farmers to expand irrigated land, and while this has enriched rural economies, it's come at the expense of biodiversity and those who rely on hay production—ranchers. And then the drought threw in a sucker punch, knocking hay production off its heels. Earlier this year, the number of cattle in the U.S. fell to 89.3 million, the smallest herd since 1952.

Back in 2008, well ahead of the drought, the Nebraska State Legislature labeled the Upper Elkhorn NRD as fully appropriated, meaning as much water was

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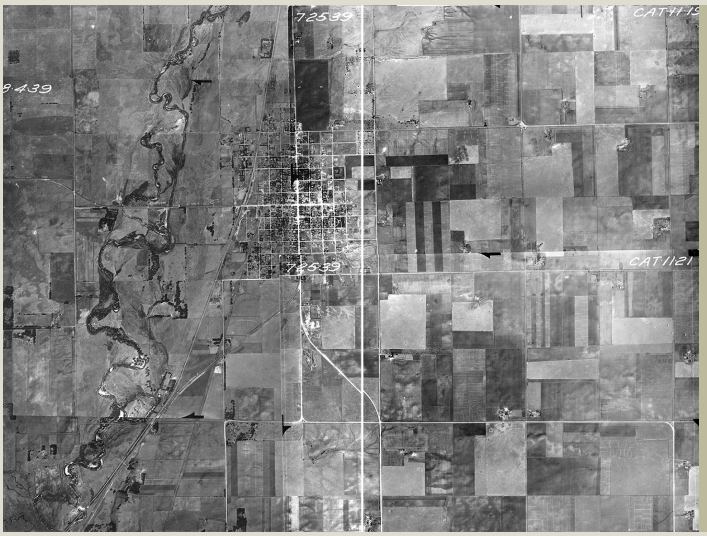


Around O'Neill, six decades of irrigation development have created new livelihoods and landscapes. The aerial view at right, a current image (Imagery ©2013 DigitalGlobe, Landsat, USDA Farm Service Agency, Map data ©2013 Google) shows widespread use of center pivot irrigation, in contrast to the view at left, from 1939, courtesy of the Nebraska Department of Roads.

Groundwater data, continued

Despite spring recharge, streamflows along the Elkhorn River are still well below normal.

leaving the ground as was returning. So the board limited the expansion of irrigation to 2,500 acres per year, or about one half of one percent of the land already irrigated with groundwater. To some, the NRD may have seemed like the cautious friend who urges moderation before taking down another whiskey at a rock concert; still others saw Confucian self-restraint. The recent drought appears to rubber stamp Schueth's cautious approach.

"We think that the drought was an eye-opening experience, and we need to take a step back and look to see what all of the trends are," Schueth says.

A hasty overcompensation, like swerving across a highway after drifting onto its shoulder, often does more harm than good. That's how John Turnbull sees it from his post as general manager of the Upper Big Blue Natural Resources District in York, Nebraska. A straight-talker who flew Hueys in Vietnam, he keeps a level head in tense situations. During the drought, when his district pumped nearly twice the average irrigation water and groundwater fell by more than 4 feet, Turnbull remained circumspect.

"If all of a sudden we came in here and tried to set regulations, we would have a severe political reaction against us. People don't react that fast to change. It's taken us a generation to get where we're at," Turnbull cautions.

The Upper Big Blue alone irrigates as much land as in the entire country of Germany: 11,800 irrigation wells pinprick over a million acres and bestow shimmering rows of corn and soybeans. A decade ago, an allocation trigger was set up to ration water should levels plunge to their historic lows of the late-1970s. In 2006, groundwater levels receded enough to trip a reporting trigger, compelling farmers, municipalities and industrial water users to report their annual water consumption to the NRD.

To Turnbull, who's been with the NRD since 1978, the 2012 drought is a supporting actor while

"If all of a sudden we came in here and tried to set regulations, we would have a severe political reaction against us. People don't react that fast to change. It's taken us a generation to get where we're at ..."

– John Turnbull, Upper Big Blue NRD

A pivot sprays water on a fresh field near Neligh, Nebraska.

the larger, gradual trend towards conservation and transparent measurement is stage front and center. “The attitude was ‘Don’t put a meter on my well. You don’t have the legal right to tell me how to use my water,’” Turnbull says, paraphrasing the fading angst. But today, he says he’s more likely to hear, “We understand why you’re trying to allocate this groundwater because you’re trying to sustain it for a very long period of time and we want our kids to farm in the future.”

On the outskirts of O’Neill, down the hall from Schueth’s office, Tom Riley is peering into his 17-inch flat screen monitor. Staring back is what looks like an aerial game of Pac-Man, with greenish three-quarter circles munching on earth-tone pellets. As the Upper Elkhorn NRD’s Water Resources Manager, Riley sees the imprint of center pivot irrigation from the sky and below the ground like few others. In parts of his backyard, atop the High Plains Aquifer, the water table glistens right at the surface, undergirded by saturated thicknesses of 300 to 400 feet. But if the years get hotter and drier, like they did in 2012, the way we manage those depths will speak both hydrologic and ecological volumes.

“There is a limit to how much irrigation we can develop and still maintain these other,” he pauses to consider this last word, “ecosystems.”

Back in his office at the University of Nebraska-Lincoln’s East Campus, Aaron Young is ready for a road trip. He’s off to a few of the 100 groundwater wells he measures across the state. The readings from his digital dipsticks will help inform this fall’s comprehensive report. This is not high-profile science. It’s unlikely to be published in Science. And it’s not done for personal glory.

Dennis Schueth, Upper Elkhorn Natural Resources District General Manager, outside headquarters in O’Neill, Nebraska.

In the future, maybe an alliance of water conservationists, irrigating drones, innovative policies and enhanced crops will deflect the ravages of drought. But for now, in the face of the worst drought in memory, we need Aaron Young perhaps even more than he knows. His work will help us answer a fundamental question he poses near the end of our conversation.

“What do we do, as a society? We have to make some choices, land use choices, on what we’re doing with this land.”

See the companion video on water levels

NDMC climatologist Tsegaye Tadesse takes VegDRI to Mexico

Mexico is working to implement drought monitoring that integrates climate, satellite and environmental information – an approach similar to the Vegetation Drought Response Index (VegDRI) developed through a partnership of the National Drought Mitigation Center and the U.S. Geological Survey's Earth Resources Observation and Science (EROS) Center.

Tsegaye Tadesse, NDMC climatologist and remote sensing expert, and Jesslyn Brown, EROS geographer, traveled to Mexico City in April 2013 to work with Mexico's Agricultural and Fisheries Information Service on how Mexico can implement its own version of VegDRI and to present at the XIII Agricultural Outlook Forum 2013. Brown and Tadesse developed the prototype VegDRI for the U.S. starting in 2002.

"We have to integrate climate, satellite, hydro-meteorological and environmental data to be most efficient and proactive with drought early warning. For those countries like Mexico that don't have enough networked weather stations, satellite data are very important. These data would help to fill the gap when there are few ground observations."

Decision-makers can use early warning of drought to help reduce its impacts, ranging from economic losses in developed countries to famine and mass migration in developing countries, Tadesse said in his presentation to the forum.

"We have to integrate climate, satellite, hydro-meteorological and environmental data to be most efficient and proactive with drought early warning," Tadesse said. "For those countries like Mexico that don't have enough networked weather stations, satellite data are very important. These data would help to fill the gap when there are few ground observations."

In the United States, though it's not perfect, climatologists and decision-makers benefit from automated, networked climate monitoring stations. The NDMC works with the High Plains Regional Climate Center to access network data.

One of the first steps in developing a Mexican version of VegDRI has involved scientists in Mexico assembling data on climate, soils and other related variables, Tadesse said. Researchers world-wide have free internet access to satellite data on vegetation conditions collected and distributed by U.S. agencies, such as EROS. Next, researchers will create a regression-tree model to integrate all the different data inputs, and will produce a Mexican version of the VegDRI map that shows vegetation conditions. The final stage will be evaluating and adjusting the model based on ground observations such as crop yield. This could eventually lead to some predictive capability that will help in food security management.

Tsegaye Tadesse, NDMC climatologist, center, with Jesslyn Brown, USGS EROS geographer, left, and their facilitator, right, in front of the Angel of Independence in Mexico City.

Tadesse's research focuses on developing the Vegetation Drought Outlook, or VegOut, which would build on the understanding developed through VegDRI to identify patterns in data and project them into the future. He added that models eventually need to take the changing climate into account, because the past is now less likely to be a guide to the future.

VegOut would be a predictive tool, building on the understanding developed through VegDRI. "VegDRI is essential because unless you know what's happening now, it's meaningless to talk about the future," Tadesse said.

Tadesse and Brown also attended the XIII Agricultural Outlook Forum 2013, organized by SAGARPA, Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food. The presentations that Tadesse and Brown made are available online.

Spanish scientist refines remote sensing of drought for forests

Cristina Domingo-Marimon, from the Geography Department at the Autonomous University of Barcelona in Spain, is a visiting scientist at the NDMC, April 15-July 31. Her doctoral studies focus on the characterization of drought patterns over forested areas through remote sensing. She is particularly interested in the unmanaged privately owned forests that cover 60 percent of the land in Catalonia, where fire is a frequent risk.

Domingo-Marimon is working with Brian Wardlow, formerly with the National Drought Mitigation Center and now director of the Center for Advanced Land Management Information Technology, with Mark Svoboda, leader of the NDMC's Monitoring Program Area, and with Mike Hayes, director of the NDMC. CALMIT is also based at the School of Natural Resources at the University of Nebraska-Lincoln.

"They are really good," she said. "Talking with them gives me a new framework for the whole discipline, from the most theoretical to the most applied."

Eventually, remote sensing of drought may be able to help provide early warnings of fire risk, Domingo-Marimon said, although her research will primarily focus on determining which data provide the best temporal and spatial resolution for the purpose. She is working with researchers here to evaluate LANDSAT and MODIS data, and to learn how to combine remote sensing data with climatological data and indices.

"The idea is to try to evaluate remote sensing tools as a monitoring system for specialized researchers, fire managers and end users," she said. Some ground truth is available from a network of forest agents that report on forest conditions.

A fellowship from the Spanish government is supporting her work with the NDMC. Domingo-Marimon has also studied at the Universitat Trier in Germany.

Although Lincoln, Nebraska, isn't exactly the America of big cities and skyscrapers that the international community sees most frequently, Domingo-Marimon is enjoying the Great Plains lifestyle and has found other inquisitive people with whom to explore Lincoln and nearby cities.

On a trip to Colorado, Cristina Domingo-Marimon visited Summit Lake at Mount Evans in Arapaho National Forest. Behind her is a ridge that goes from Mount Spalding (right, 13842 ft) to Mount Evans (left, 14264 ft).

U.S. Drought Monitor sculptor wins Distinguished Artist Award

Congratulations to Jess Benjamin, who received a $5,000 Distinguished Artist Award for 2013 from the Nebraska Arts Council. Benjamin, who grew up on a farm near Cozad, Nebraska, produces work that focuses on water usage in the Great Plains. Her sculptures include various renditions of U.S. Drought Monitor maps. The Omaha-based sculptor currently teaches ceramics at the University of Nebraska-Omaha. Benjamin's work will be on display at the 2014 Center for Great Plains Studies Symposium on Drought in the Life, Cultures and Landscapes of the Great Plains. The photo at left is Benjamin's comparison of drought in 2002 with drought in 2012, and at right is a faucet and bucket. All executed in ceramics.

U.S. Drought Monitor Forum focuses on tropics, impacts

This year's U.S. Drought Monitor Forum, held in April in West Palm Beach, focused on drought in the tropics. A third day was largely focused on drought in the Caribbean and the Pacific. Many thanks to the South Florida Water Management District for hosting this year's meeting, including excellent meeting space and dedicated technical support.

The U.S. Drought Monitor Forum, alternating with the North American Drought Monitor Forum in Canada or Mexico, provides regular opportunities for U.S. Drought Monitor authors and stakeholders to meet to fine-tune the processes and the data that go into the weekly map showing the location and intensity of drought. The map, hosted by the National Drought Mitigation Center at the University of Nebraska-Lincoln, is produced each week in a joint effort by the NDMC, the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, and a nationwide network of observers.

Presentations and recordings are online: http://drought.unl.edu/NewsOutreach/Outreach/Workshops/USDroughtMonitorForumWestPalmBeachFL.aspx

Tommy Strowd, deputy executive director of Operations, Maintenance and Construction for SFWMD, gave a presentation on "Balancing and Managing Flood Risks and Droughts Now and in the Future."

At left, U.S. Drought Monitor authors on a panel were, from left, Eric Luebehusen, meteorologist, Office of the Chief Economist, U.S. Department of Agriculture; Brian Fuchs, climatologist, National Drought Mitigation Center; Mark Svoboda, climatologist, NDMC; Matthew Rosencrans, meteorologist, Climate Prediction Center, National Oceanic and Atmospheric Administration; and David Simeral, Western Regional Climate Center, Desert Research Institute.

Mary Ann Martin of Roland & Mary Ann Martin's Marina Resort, a premiere bass fishing spot in the Everglades, detailed successes that came as drought spurred the marina to diversify offerings.

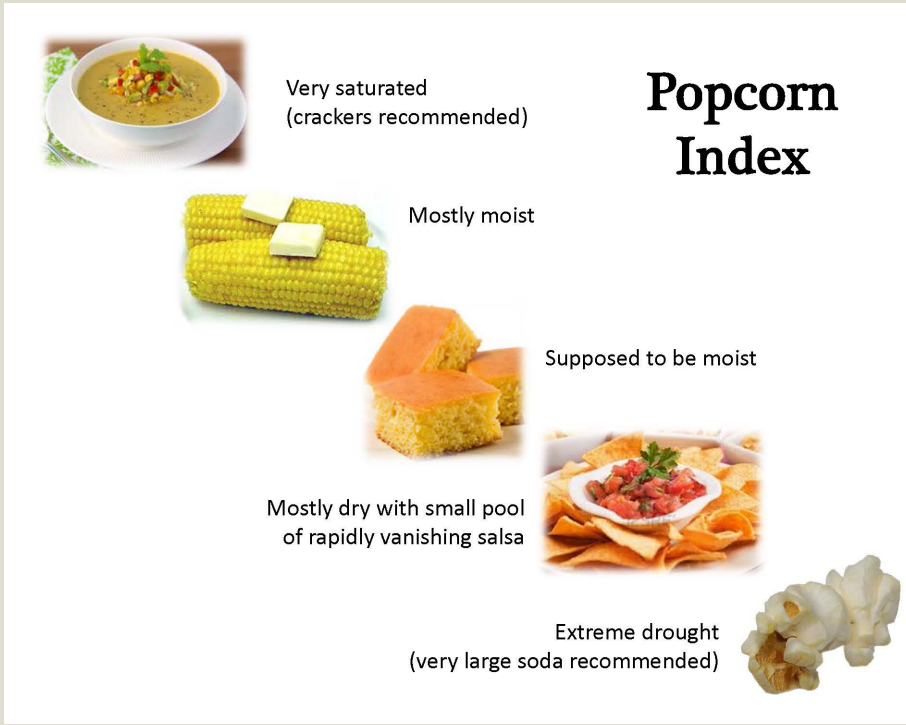
During a sticky wall activity, below, participants helped diagram how drought impacts could be collected and monitored to be of greatest use in decision-making.

Members of the Caribbean delegation discussing ways to advance drought monitoring were, from left, Trevor Thompson, Ministry of Agriculture, Forestry and Fisheries, Grenada; Michael Taylor, University of the West Indies, Jamaica; and Adrian Trotman, Caribbean Institute for Meteorology and Hydrology. Fuchs and Svoboda, who gave a workshop in the Caribbean in 2012 on drought monitoring, were very pleased to learn of the progress in implementing drought monitoring that had occurred since their visit.

Kati Corlew, researcher at the Pacific RISA/East-West Center, discussed the challenge of monitoring drought at island scale.

Jim Angel, Illinois State Climatologist, presented the Central United States 2012 Drought Assessment. Later, during discussion, he reignited a lively conversation on whether U.S. Drought Monitor drought severity classifications should go up to D5.

Jeri Muoio, Mayor of West Palm Beach, above, talked about how the city has coped with drought.



Robert V. Sobczak, hydrologist at Big Cypress National Preserve, gave a particularly entertaining presentation in which he proposed the creation of a Popcorn Index to describe stages of dryness. On a more serious note, he discussed infrastructure updates that could help prevent wildfire in the Everglades.

Workshop helps New Mexico ranchers cope with drought

A workshop in Socorro, New Mexico to help ranchers deal with drought drew 152 participants, including many who stayed through the afternoon to start developing drought plans for their ranching operations.

The workshop was a joint effort by the National Drought Mitigation Center, the National Integrated Drought Information System, New Mexico State University, and the New Mexico Chapter of the Society for Rangeland Management.

The day's events included an assessment of drought conditions and the prospects for improvement; techniques to help manage livestock and forage resources during drought; and an interactive session on drought planning for ranchers.

Speakers included Nathan Combs, NMSRM; Elizabeth Driggers, field representative for Sen. Tom Udall; Chad McNutt, NIDIS program officer; Deborah Bathke, NDMC; Dave DuBois, New Mexico State Climatologist; Dave Brown, National Oceanic and Atmospheric Administration, Climate Services, Southern Region; Chuck Maxwell, New Mexico Southwest Coordination Center; Nick Ashcroft, NMSU; Joel Brown, U.S. Department of Agriculture, Natural Resources Conservation Service and Jornada Experimental Station; Manny Encinias, NMSU; Jerry Hawkes, NMSU; Tonya Haigh, NDMC; and Laurie Abbott, NMSU. John Longworth of the New Mexico State Engineer's Office also helped field questions.

During the planning session, participants were asked several main questions. A few of the hundreds of answers are reproduced below; the full list will appear on the workshop webpage.

Ranchers at a workshop in Socorro, New Mexico, discussed how they could make their operations more drought-resilient.

What decisions need to be made during and after drought?

- Feed or sell -- THE QUESTION
- Reduce or relocate

What do you need to know to make decisions?

- Sale prices
- What could happen?

Where do you find the information?

- Any agency: federal or county
- Internet/mass media
- Sounding board – neighbors, friends, etc.

When should decisions be made?

- Late spring: Can you make it to monsoon
- July 15-August 15: evaluate precipitation received
- October 20-Thanksgiving when weaning – decide to sell or carry over

What resources and opportunities are available to support potential strategies?

- Participants listed numerous resources under Community Capitals: Built, Financial, Political, Social, Human, Cultural, and Natural

What are some mitigation and recovery strategies to consider?

- Destock to fit resources
- Feed from other sources – potatoes, pumpkins, cookies, etc.
- Fix leaky pipes

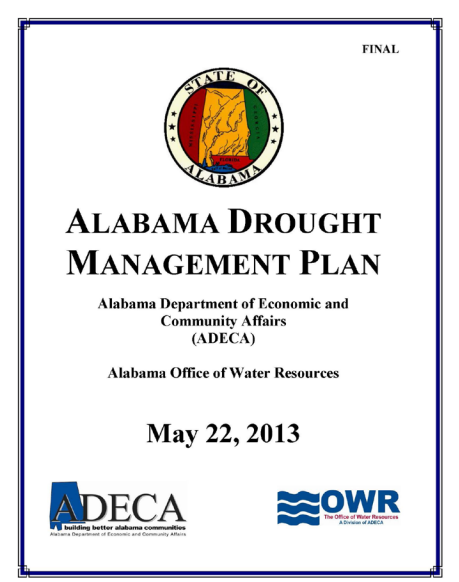
To learn more about the workshop, including accessing presentations and recordings, please visit the workshop webpage: http://drought.unl.edu/ranchplan/Overview/Resources/Socorro,NewMexicoMay29,2013.aspx

Read "Drought workshop draws crowd to Socorro," by Susann Mikkelson, *El Defensor Chieftain*, June 6, 2013, http://www.dchieftain.com/2013/06/06/drought-workshop-draws-crowd-to-socorro

To request a similar workshop, please contact Nicole Wall, nwall2@unl.edu, 402-472-6776.

For your drought preparedness reading list:

Alabama implements new drought plan



The State of Alabama released a new Alabama Drought Management Plan in May, which "outlines for the first time state government's role in preparing the weekly snapshots of current drought conditions, and specifies steps to be taken in response to potential drought conditions," according to the official press release.

The Alabama Department of Economic and Community Affairs' Office of Water Resources is the lead agency. "Unlike other natural disasters that strike with sudden fury, droughts work slowly and silently to destroy crops, create shortages for local water systems, reduce power production, harm pulp and paper and other industries creating job losses, and degrade our waterways making them unsuitable for recreation and other activities," ADECA Director Jim Byard said. "The new plan will guide our Office of Water Resources as it constantly monitors water availability so that Alabamians can be alerted and proactive steps can be taken to lessen the impact of a drought."

The plan specifies that state officials will:

- Work with the state climatologist and the Monitoring and Impact Group of the Alabama Drought Assessment and Planning Team to contribute input on Alabama to U.S. Drought Monitor authors;
- Maintain a web-based Drought Information Center for the public;
- Issue Alabama drought advisories based on information collected by the Monitoring and Impact Group;
- Analyze potential drought impacts on residents, agriculture, habitat, water recreation and other industries that rely on water for production.

Visit Alabama's Drought Planning and Management page: http://www.adeca.alabama.gov/Divisions/owr/Pages/Drought.aspx#Planning

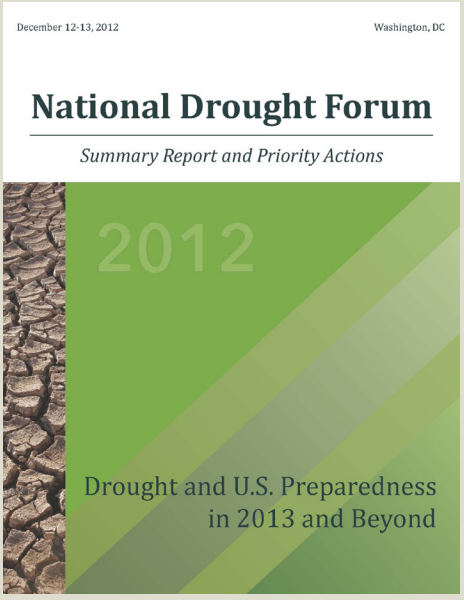
Read the State of Alabama press release, "Plan outlines state government's response to drought conditions," May 22, 2013 http://www.media.alabama.gov/AgencyTemplates/adeca/adeca_pr4.aspx?id=7828

Access the NDMC's full collection of state drought plans: http://drought.unl.edu/Planning/PlanningInfobyState.aspx

Report helps launch drought impacts community of practice

http://www.drought.gov/media/pgfiles/Drough_Impacts_Report_June2013_final.pdf

National Drought Forum findings highlighted



http://www.drought.gov/drought/content/national-drought-forum-summary-report-and-priority-actions